Efficient Deployment of Personalised iDTV Advertising over DSL Networks

Philip Leroux , Valentijn Verbrugghe, Wim Holvoet, Filip De Turck and Piet Demeester
Ghent University – IBBT, Department of Information Technology,
Gaston Crommenlaan 8 bus 201, 9050 Gent, Belgium
{Philip.Leroux, Valentijn.Verbrugghe, Wim.Holvoet, Filip.DeTurck, Piet.Demeester}@intec.ugent.be

Abstract
As interactive Digital TeleVision (iDTV) is gaining importance at the expense of the traditional media, the advertising market is going through some radical changes. New use cases such as interactive branded content and interactive advertising are slowly becoming an every day reality. However, as devices with personal video recording functionality are also finding their way to the consumers' houses, advertisements may be skipped and major revenues may be lost. By making advertisements more personalised, they become more appealing to the user which increases their efficiency and makes them less skipped. In this paper, we present a middleware architecture for the deployment of advertisement services that are both highly interactive and personalised. This middleware platform supports advanced interactive use cases, is easily extendible and is designed with cross-device deployment in mind. In this paper, we specifically target a Digital Subscriber Line (DSL) network architecture.

1. Outline

The paper is organized as follows. In Section 2, we amplify on some relevant advertisement use cases as requirements for the design of the architecture. Focus is on both interactivity and personalisation. Section 3 gives an architecture overview, explaining where extra functionality should be added to an Ethernet-based DSL aggregation network. In section 4, the client's middleware platform is presented and in section 5 we describe a scenario that details the delivery of personalised services. Finally, section 6 states our conclusions and future work.

2. Personalised iDTV Advertising

In order to define the functional requirements of our advertising system, some possible use cases that perfectly suit the new advertisement channels had to be defined. This section briefly introduces the use cases that our system at least should provide support for. These use cases [1] were intensively discussed and reviewed during the ADME [2] project. This project investigates what strategies can be developed to give publishers of daily and weekly newspapers as well as commercial broadcasters more resources in the brand and classified advertising markets. This section first details some interactive use cases and then focuses on the aspect of personalised advertising.

2.1 Interactive Advertising

Two typical examples of interactivity related advertising use cases are 'interactive branded content' and 'interactive advertisements'.
Interactive branded content occurs when a brand clearly comes into sight during a television program. At the same time, a message on the screen tells the viewer that some type of interactivity is possible. This might be requiring more information about the product, receiving a discount order, participating in a game, etc. An addition to this use case is to provide a bookmark system for the advertisements thus allowing the viewer to not interrupt the program he is currently watching. When the program has finished, the viewer can consult his bookmarks and view the interactive advertisement.
Interactive advertisement is very similar to the use case of interactive branded content. But this time a person is watching the normal version of an advertisement. A message on the screen tells the person that an interactive version exists. Again the viewer may have the same options as in the previous use case.
In these two use cases, it is possible to send the information to yourself through e-mail or keep the information as a bookmark in a publicity guide. With the creation of a buddy list, it would also be possible to recommend an advertisement by sending the information to your contacts, or add a bookmark in their publicity guide.

2.2 Personalised Advertising

Personalised advertising refers to the individual targeting of each consumer by only showing them those advertisements they may be interested in. Personalised services are implemented by using profiles and profiling algorithms [3]. Every user has his own profile which contains his interests, the types of advertisements he likes, etc.

When several viewers are watching on the same set-top box (STB), profiles may be combined or overall profiles may be used.
There are different ways to build a profile [4]. After evaluating the different algorithms, we finally choose the TV3P algorithm [5] because of its good real-time performance, great scalability and large and fast accumulation of information.
The TV3P algorithm is used to recommend television programs and is based on the programs' content and the preferences of the user. The Vector Space Model is used which represents the user profile as well as the program profile as a vector 2-tuples. Every 2-tuple exists of a term and a weight. To give a score to a program, the correlation between the two vectors is made by taking the cosine of the corner between the two vectors. The algorithm gives a method to refine the user profile. This method is based on explicit and implicit feedback. The weights are updated using the previous weight, the user actions and a learning rate. TV3P also has a notion of the content when good terms are chosen. The only thing TV3P needs is for each user and each advertisement a vector with its terms and weights.

3. Architecture Description

Fig. 1 presents the architecture that we use for the deployment of personalised iDTV services over DSL (Digital Subscriber Line) networks. Fig. 1 shows an Ethernet-based DSL aggregation network (cfr. TR-101 [6]). However, all the concepts and ideas may be easily mapped to (classical) ATM-based DSL. Starting from the basic subdivision that can be made in every DSL network, we explain which components are added in each part of the network.

3.1 Service Providers

Basically, there are three types of service providers: the Network Service Provider, the Internet Service Provider and the Application Service Provider (ASP). The ASP typically hosts one or more Video Servers which stream the content, provided by the Content Provider, to the clients.
In our architecture, two extra components are added to the ASP. The first component is the so-called *Interactivity Server*. The interactivity server is the central component for the delivery of the synchronised, interactive services. This server generates data streams to the multicast IP network and handles incoming client requests via the bidirectional unicast channel.
The second component is the *Advertisement Server*. This server's main task is the on time provisioning of all the advertisements and their profile mapping related data into the network. As opposed to traditional TV architectures where advertisements are encapsulated in the content provider's video stream, the advertisements are now sent separately to the Access Network. Management of these advertisements thus becomes the responsibility of the ASP instead of the Content Provider!

3.2 Regional Broadband Network

Fig. 1 shows an IPTV multicasting setup using a dual edge (although this is optional) to split off the video services. The ASP feeds IPTV multicast streams from the video server to the video Broadband Network Gateway (BNG) across the core network.

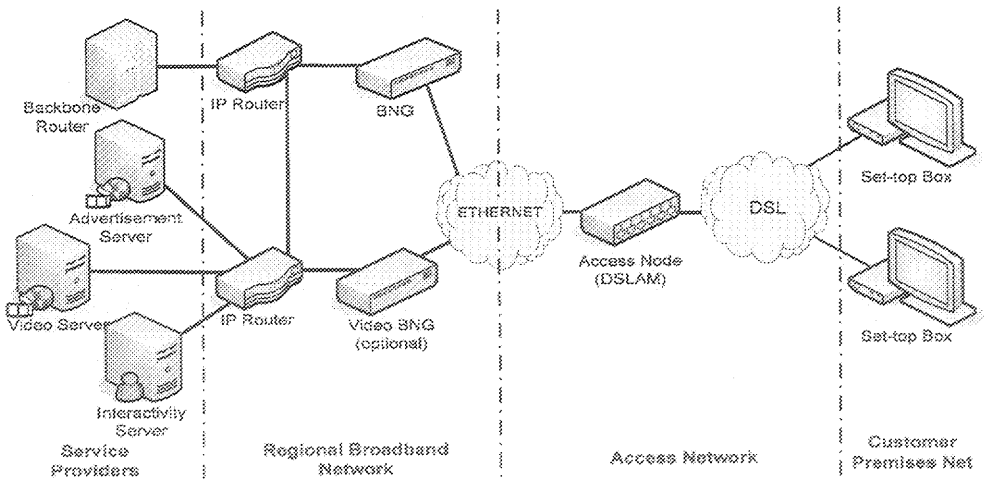

Fig. 1: An Ethernet-based DSL aggregation network, supporting personalised iDTV advertising.

Both the Advertisement and the Interactivity server multicast their data to the Access Network through the same Video BNG as the Video Server. In our architecture, no extra components are added to this part of the network.

3.3 Access Network

As shown on Fig. 1, the Access Network's main component is the Digital Subscriber Line Access Multiplexer (DSLAM). This is a network device, located near the customer's location, connecting multiple customer DSLs to a high-speed Internet backbone line using multiplexing techniques. It is actually on the DSLAM that most functionality is added in order to support personalised services. Implementing all the required logic earlier into the network would incorporate issues with respect to user identification. Implementing the application logic later into the network would make the whole solution not scalable as all advertisements, also those that are not appropriate for a given costumer, would have to be sent to the costumer premises. In order to support personalised advertisement, the DSLAM is extended with 4 major components.

A *large advertisement buffer* is added for storing all the advertisement objects that are multicasted by the Advertisement Server. Such an advertisement object consists of video data, a metadata file which contains profile information and additional application logic if the advertisement is also interactive.

A *Profile Server component* is used for interaction with the Profile Managers, located on the STBs (cfr. Section 4), in order to continuously update its link between all the STBs the DSLAM is responsible of and the TV3P profiles currently active on those boxes.

TV3P matching algorithms are implemented in order to link a certain advertisement to a certain profile. In Section 2.2, a short introduction was given about how TV3P profiles are matched together.

Finally, *advertising encapsulation application logic*.sends the personalised advertisement's video data to the viewer exactly when a personalised advertisement block is foreseen by the content provider. In order to identify the exact first frame of such a personalised advertisement block, additional information concerning the Video Server's data is sent to the DSLAM. In our setup, this task is fulfilled by the Interactivity Server as this server keeps track of the exact time clocks of the video data in order to support synchronised interactivity. In order to not disturb the beginning of a program after the commercial break, all personalised advertisements should have the same predefined number of frames!

3.4 Customer Premises Network

At the Customer Premises Network, we targeted STB on which we implemented our own application middleware for providing highly synchronised, interactive services. This middleware uses some concepts of the Multimedia Home Platform (MHP) specification [7] but is developed specifically for our own requirements. The number of use cases that the middleware supports is easily extendible. Section 4 elaborates on this middleware platform.

4 The Interactivity Middleware Platform

In order to provide personalised iDTV services, a client-server middleware framework was developed with the server middleware provided by the extra components in the network and the client middleware implemented on the STBs. Interactive services require tight synchronisation between what is actually shown on the user's screen and the interactivity-related components that should appear on the screen. Starting from the MHP specification, we implemented our own Event-Trigger framework. An Event is the description of a specific action that can be executed by a downloaded application. A Trigger informs the application logic on the client device when a specific event needs to be executed. It is the Interactivity Server, described in Section 3.1, that steers all the STBs by using an Event-Trigger mechanism.

On the STBs, Java application logic was used to provide the interactive services. As our client middleware is developed on top of an OSGi framework [8], Java application logic is dynamically installed and managed. The client's middleware architecture is shown on Fig. 2.

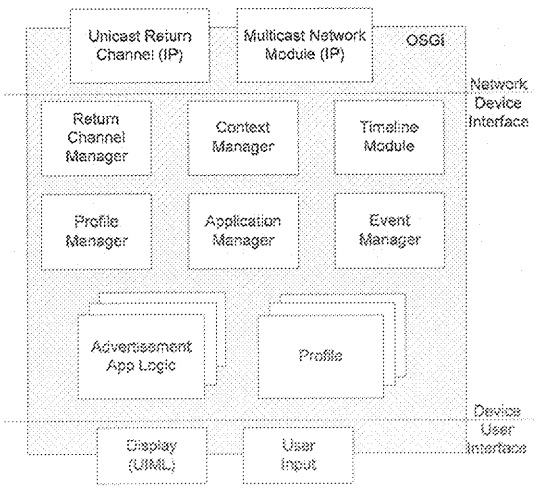

Fig. 2: Personalised iDTV client architecture.

The initialization, starting, stopping and destroying of all the *Advertisement Application Logic* is handled by the *Application Manager*. The *Event Manager* provides the dynamic definition of events, and the delegation to the correct Advertisement Applications. The *Return Channel Manager* provides an interface for the applications to the (IP) *Unicast Return Channel* module. A return channel is very important in advertisement use-cases as it allows the users to send information back to the Service Provider. This may be a recommendation to someone in the buddy-list, a pull-request for showing more information concerning a certain product on the screen, a mobile phone number for supporting mobile couponing, etc. The *Display* and *User Input* modules provide platform independence and can be seen as an interface between our middleware system and some device-specific libraries. The *Timeline* module is used in order to synchronise the Scheduled Events with the broadcasted advertisements. The *Context Manager* module is implemented to store the current context (which channel is currently watched, which applications are running, etc.).

The *Profile Manager* is the central component for the execution of all the personalisation related tasks:

- Efficient management of the different *Profiles* on the device. This includes creating new profiles and keeping all the existing profiles up-to-date. Updating the profiles incorporates the analysis of the (logged in) user's viewing habit and his actions when interactive advertisements are shown on the screen.
- Provisioning of identification logic on the STB. In our case, the Profile Manager is responsible of showing a simple on-screen login menu. Note that this manager may also interact with the smartcard-interface which is available on some STBs.
- Keeping track of the currently active profiles and determine how profiles may be combined by choosing the right overall profile that encompasses multiple viewers (e.g. family profile, kids minus 12 years old profile, etc.)
- On-time notification of the DSLAM concerning which (overall) TV3P profile is currently active on a certain STB.

5 Personalisation Scenario

This section describes the scenario how a personalised, interactive advertisement is sent to the viewer's STB. Fig. 3 is a sequence diagram which highlights the working of some of the components that were added to a plain DSL network architecture. The standard DSL components and their interactions are not shown for the sake of clarity.

The Advertisement Server periodically sends Advertisement Objects via an object carousel to all the DSLAMs in the network. The DSLAM's Advertisement Buffer stores all these objects and when the carousel has ended it sends its Profile List to the Profile Server. A Profile List contains all the profile related metadata of each Advertisement Object that is stored on the Advertisement Buffer.

The Profile Server makes a new correlation between the currently active profiles on the STBs and all the advertisements that are stored on the Advertisement Buffer. The Advertisement Buffer also sends the Advertisement Application Logic of an associated advertisement to the correct STB. When a viewer logs in, the STB identifies the user, chooses the best profile and sends this profile to the DSLAM's Profile Server. The Profile Server then (re)calculates the best fitting advertisement for this active profile.

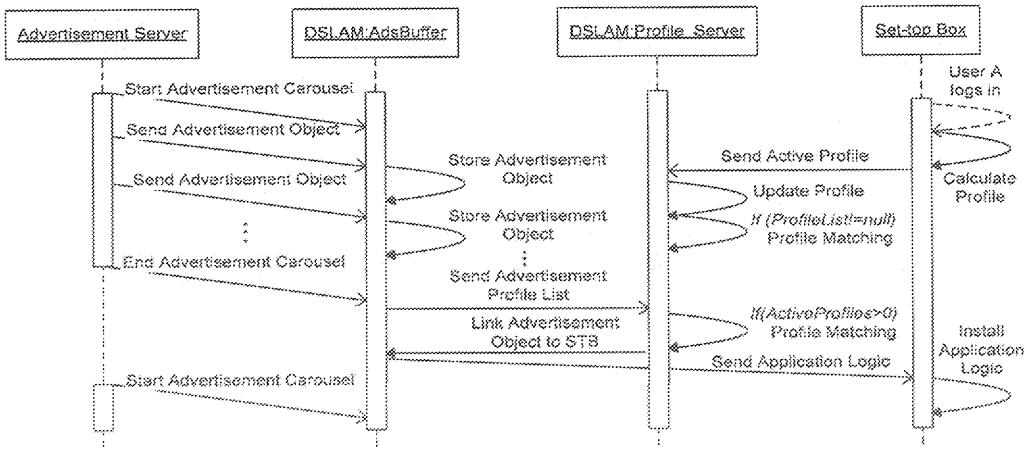

Fig. 3: Sequence diagram detailing profile matching in the network.

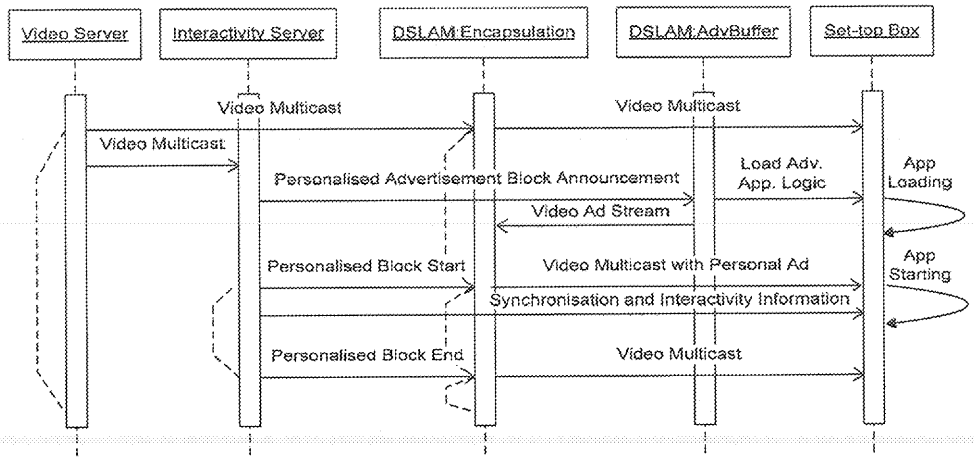

Fig. 4: Sequence diagram detailing the advertisement encapsulation.

Fig. 4 shows a sequence diagram that details how the personalised advertisements are sent to the STBs. The video server is multicasting the content providers' video content to the DSLAMs. The Interactivity Server has also joined these multicast streams and analyses each video channel in order to synchronise its interactivity clock with the multicasted video clock. Based on the additional information that the Interactivity Server receives from the content providers, the Interactivity Server steers the DSLAM's Advertisement Buffer. When the advertisements contain interactive services, the Interactivity Server also steers the time clocks on the STBs in order to synchronise the advertisement application logic with the broadcasted advertisement.

6 Conclusions and future work

In this paper, we presented an architecture for the efficient deployment of personalised and interactive advertisement services in a DSL based DTV architecture. By using an event-trigger mechanism and by mapping the events to the video time line of the broadcasted content, interactivity could be synchronised with the interactive advertisements. Personalisation was implemented by using profiles and the TV3P profile algorithm. In order to build a scalable solution for these personalised services, some special considerations had to be taken into account. The functionality of the DSLAM had to be extended, management of the advertisements is now part of the Application Service Provider and extra functionality had to be implemented on the set- top boxes. On these set-top boxes a middleware platform was implemented that was based on existing standards such as the DVB-MHP and OSGi. This middleware platform's main strength is the fact that its functionality may be easily extended.

The current boom of mobile television services over broadcast networks is a good opportunity to map the concepts of this paper to the mobile domain. As DVB-H becomes the standard for mobile TV broadcasting in Europe, it is very interesting to incorporate personalised, interactive services into a DVB-H network architecture. The main challenge with DVB-H is its broadcast nature and hence the absence of a return channel. Currently, we are developing a prototype to demonstrate interactive services over DVB-H.

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References

1. Berte, K. (2007). The evolution of the advertising investments in the Belgian Mass Media (2000 - 2005): Trends and Interpretations. 5th International Conference on Communication and Mass Media, Athens.
2. ADME, Advertising in a Digital Media Environment, https://projects.ibbt.be/adme/ (2008).
3. Deshpande, M., Karypis, G. (2004). Evaluation of Item-Based Top-N Recommendation Algorithms. ACM Transactions on Information Systems.
4. De Pessemier, T. (2007). A profile based recommendation system for TV-Anytime annotated content. 8th PHd Symposium, Ghent.
5. Yu, Z. and Zhou, X. (2004). TV3P: an adaptive assistant for personalized TV. IEEE Transactions on Consumer Electronics 50, 1, 393-399.
6. Technical Report DSL Forum, TR-101: Migration to Ethernet-Based DSL Aggregation (2006).
7. Piesing, J. (2007). The DVB Multimedia Home Platform (MHP) and Related Specifications. Proceedings of the IEEE, 94(1).
8. OSGi, http://osgi.org/ (2008).

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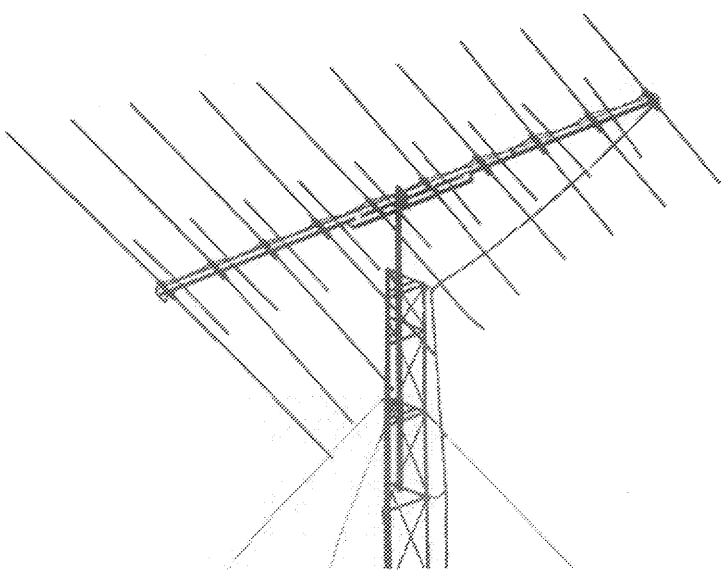

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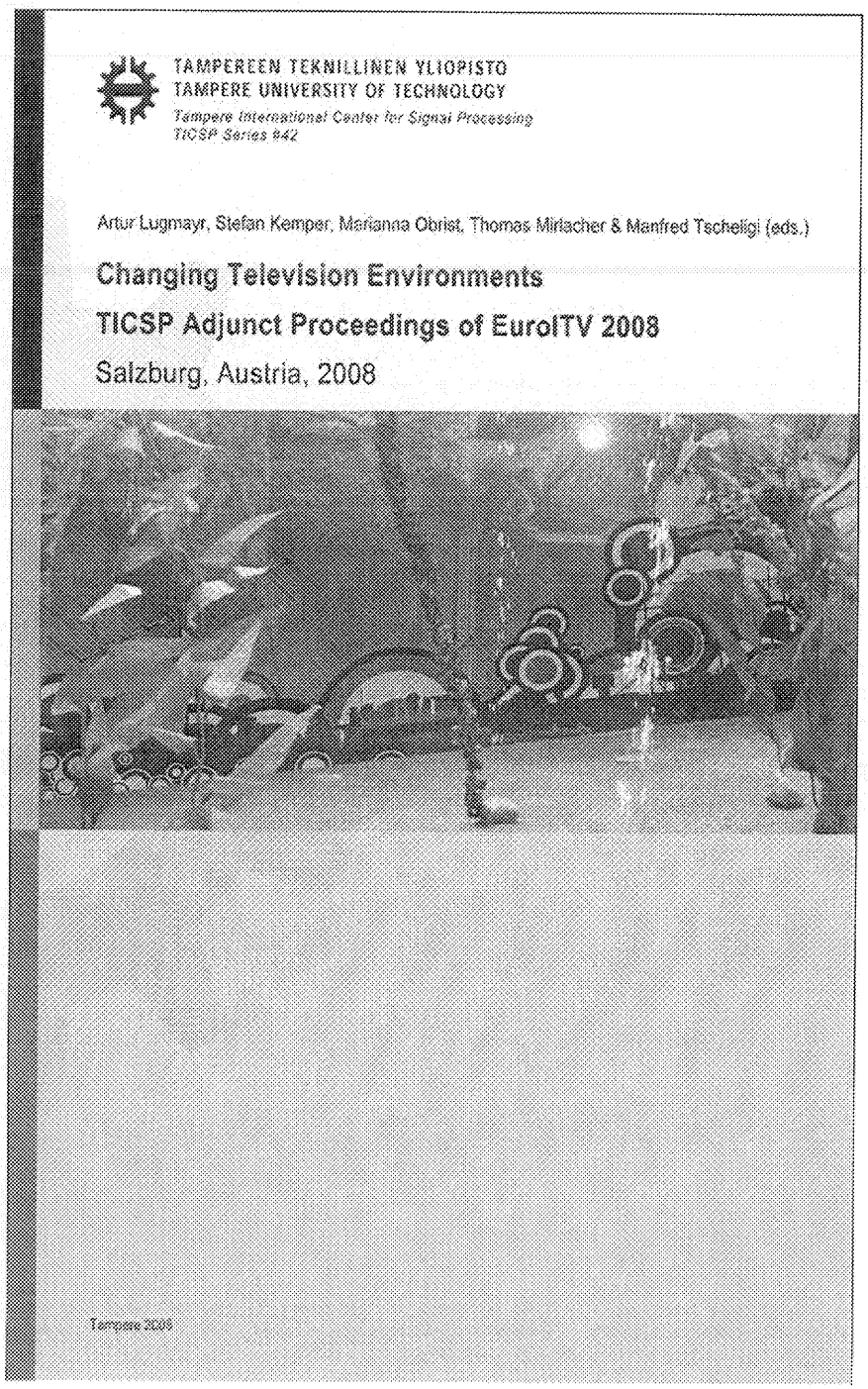

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